ARS research on harmful algal blooms in SE USA aquaculture impoundments

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Introduction

In the United States, catfish aquaculture accounts for around 70% of the total freshwater revenue (currently around $1 billion annually). During the 15-18 month stocker-sized fry to fillet turnover, effusive algal growth results from the high stocking and feeding rates. Approximately 1.5 mg/L N in the form of unassimilated feed and fish excreta is added to ponds on a daily basis. Pond management must contend with maintaining algal blooms to process this nitrogen while preventing bloom collapse and hypoxic to anoxic dissolved oxygen conditions. In 1999, an Agricultural Research Service (ARS) research unit was formed to assess optimal pond management scenarios for fish production. This program can be divided into two major components: 1) prediction of harmful algal bloom events with the goal of identifying forcing variables leading to bloom events and 2) development of rapid assessment technologies for pond management.

Methods

Microcystin, anatoxin-a, euglenophycin, and prymnesin toxins have been previously reported from this research unit. Fish mortalities have been documented from these blooms in five southeastern states (AR, LA, MS, NC, SC, and TX). In 2000, a synoptic survey of 3% of the total production ponds was conducted in the southeastern 4-state catfish production area after documentation of microcystin-fish mortalities. Water samples were collected from 485 production ponds during a 10-day period, with analyses of pigments, off-flavor, and microcystin toxins (using HPLC/MS). A PCR method using myc b gene was developed to identify algae capable of Microcystin synthesis.

Detection of algal blooms is difficult in freshwater, principally due to the alteration of reflectance from algae by suspended solids and color. At present, no modeling software is designed for use in Case II waters. Zimba and Gitelson (in review) have proposed tuning model properties to water column conditions to better estimate standing stock biomass (chl a) and applied this model to aquaculture ponds. The conceptual three-band model [R-1(l1)-R-1(l2)]×R(l3) and its special case, the band-ratio model R(l3)/R(l1), were spectrally tuned in accord with optical properties of the media and optimal spectral bands (l1,l2, and l3) for accurate chl *a* estimation were determined.

Results

Myxoxanthophyll, a cyanobacterial carotenoid biomarker, was strongly correlated with microcystin content in the synoptic survey (R= 0.92). Microcystin was detected in over 50% of all ponds sampled, with WHO limits exceeded in <1% of surveyed ponds. Myxoxanthophyll is present only in coccoid cyanobacteria and is a useful FIRST APPROXIMATION of potential toxic episodes. The PCR method had a sensitivity resolution of *ca*. 10 cells and was able to detect toxic algae at microcystin concentrations >0.25 ng/mL.

The same technique of model tuning (l1 for phycocyanin, l2 for chl) is being used for modeling cyanobacterial biomass, rather than indirect ratio methods currently used. Application of Case1 water chl model to freshwater pond data resulted in poor model fit (40-60% explained variance). This new method improved model accuracy by 14%.

Conclusions

Toxic cyanobacteria blooms occur in over 50% of aquaculture impoundments. Development of spectral models for Case 2 waters will serve as a management tool for assessment of cyanobacterial blooms.